The Social Science Journal xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

The Social Science Journal

journal homepage: www.elsevier.com/locate/soscij

# Is inequality deadly and for whom? A Bayesian Model Averaging analysis

Markus P.A. Schneider*, Yavuz Yaşar

*University of Denver, Economics, SH246, 2000 E. Asbury Ave., Denver, CO 80208, USA*

ARTICLE INFO

*Article history:*
Received 22 January 2015
Received in revised form 12 February 2016
Accepted 18 February 2016
Available online xxx

*Keywords:*
Mortality
Inequality
Health
Income distribution
Bayesian Model Averaging (BMA)

ABSTRACT

The persistent correlations between income and mortality, and inequality and mortality in the US are well established. It has been demonstrated with various empirical models at different levels of analysis. However, there is no consensus on the relevant confounding factors or even the functional specification of the income–inequality–mortality relationship across the literature. We interpret this as significant model uncertainty when it comes to the correct specification of the implied econometric model and provide a systematic approach to address it. Using BMA, we conduct a large-scale analysis considering millions of models to determine a model-averaged inequality effect explaining cross-sectional variations in mortality at the county level. The results also suggest a best set of confounding factors and emphasize the importance of controlling for unobserved State-specific factors. Furthermore, we uncover a robust nonlinear income–inequality–mortality relationship that challenges typical assumptions in the literature.



## 1. Introduction

This paper focuses on part of the inequality-health literature that studies the joint associations between income and mortality, and inequality and mortality at the aggregate level. We specifically focus on unresolved problems with confounding that obscure these relationships by establishing the set of most relevant variables that must be controlled for *before* questions of causality can be addressed empirically. Since this study uses cross-sectional data, it cannot resolve the question whether it is absolute income alone that matters or whether inequality results in additional deteriorating effects on population health via psychosocial and environmental factors, nor can we comment on the direction of causal relationships. At the same time, the increasingly unequal distribution of income in the developed world since the 1970s has made understanding the link between inequality and health outcomes (such as mortality) ever more relevant.

The income inequality hypothesis (IIH) articulated in Wilkinson (1992) posits that living in a social environment characterized by great inequality itself has direct and indirect negative effects on population health beyond what might be explained by income or resource deprivation. An extensive empirical literature emerged, investigating the correlation between a person's socioeconomic status and his/her health (particularly life expectancy or mortality, see Daly, Duncan, Kaplan, & Lynch, 1998; Kawachi, 2000; Lynch & Kaplan, 2000). The early findings based on cross-sectional studies indicated a robust correlation between health outcomes and inequality. However, the IIH has been criticized due to mixed evidence that has emerged in the more recent empirical literature based on multi-level studies. The emergent debate has focused on the empirical evidence in favor of different hypotheses (e.g., whether

* Corresponding author. Tel.: +1 303 8712 146.
*E-mail addresses:* markus.schneider@du.edu (M.P.A. Schneider), yavuz.yasar@du.edu (Y. Yaşar).

http://dx.doi.org/10.1016/j.soscij.2016.02.013
0362-3319/

the inequality–health relationship is purely induced by the shape of the income-health relationship or if there is an additional inequality effect due to psychosocial factors, as IIH stipulates) about the relationship between income, inequality, and health.

Even as recent contributions like Wilkinson and Pickett (2008) try to separate the evidence for IIH from an inequality effect induced by the shape of the income–health relationship, few question the assumptions about the shape of that income–health relationship or rigorously explores what confounding factors have to be included in the analysis to avoid biased estimators.[1] The latter shortcoming was pointed out by Lynch et al. (2004), but we believe that our study is the first to address both issues in a systematic and rigorous fashion.

We find that for the US there are indeed strong relationships between both income and mortality, and inequality and mortality, even when more direct factors that capture differences in the physical and social environment are controlled for explicitly. But these relationships are nonlinear suggesting that the underlying assumption behind an income-induced inequality effect on health needs to be revisited.

The next section offers a brief review of literature on the association between income inequality and mortality, its theoretical foundations, and recent critiques. This literature is vast and it is not the purpose of this paper to review the individual contributions to it (comprehensive reviews have been conducted by Kawachi (2000), Kondo et al. (2009), Lynch et al. (2004), Subramanian and Kawachi (2004), Wagstaff and van Doorslaer (2000)). Instead we will focus on the theoretical implications of the income–health relationship for the correlation between inequality and health, as well as for the IIH. The third section of our paper introduces Bayesian Model Averaging (BMA) as a way of accounting for model uncertainty, which we use to address the question of what controls to include to correct for confounding and functional misspecification. After discussing the data used for our analysis in section four, we present and discuss the implications of our empirical results in section five.

## 2. Inequality as a determinant of mortality

The correlation between income, inequality, and health was initially based primarily on empirical observations until the seminal article by Rodgers (1979) suggested that the relationship between income and health itself implied a relationship between inequality and health. Rodgers (1979) showed that diminishing returns to income in terms of population health also imply a negative relationship between population health and income inequality, and illustrated the point by comparing two hypothetical countries. Demonstrated even more clearly by Gravelle (1998), the concavity of the income–health relationship implies that population health should be worse in the less equal of two otherwise identical countries. In addition, the causation is believed to run from income to mortality, not the other way around. Numerous empirical studies suggest that although poor health might cause lower income, this is not "the primary mechanism behind the association between income and health" (Lynch et al., 2004, p. 10). Moreover, it is accepted that the direction and the shape (i.e., global concavity) of the association between income and health holds at both the individual and population level. The idea that any observed correlation between population health and inequality is solely induced by the relationship between income and health – by the "concavity-induced inequality effect" (Wilkinson & Pickett, 2008) – has been referred to as the absolute income hypothesis (AIH) (Lynch et al., 2004; Wagstaff & van Doorslaer, 2000).

On the other hand, there is the question in the literature as to whether this induced effect really is the only underlying cause of the observed correlation between inequality and population health. The income inequality hypothesis (IIH) answers this question by proposing two additional pathways that link income inequality to mortality (Daly et al., 1998; Kaplan, Pamuk, Lynch, Cohen, & Balfour, 1996; Kawachi, 2000; Wilkinson, 1998).[2] The first pathway is about the material dimension of daily life that is characterized by a systematic (under)investment in human, physical, health, and social infrastructure. The second pathway works through the psychosocial dimension that refers to the perceived as well as actual characteristics of the social environment that have negative effects on individual health. It would not be too simplistic to think about these pathways based on (1) human capital and its material determinants and (2) social capital and social cohesion, respectively. Inequality therefore becomes a catchall for the multi-dimensional social environment that individuals live in, many aspects of which may not be directly observable.

The entire debate rests on the observed empirical relationships between income and health, and inequality and health, yet there is surprisingly little consensus or even rigorous exploration of the relevant controls necessary to correctly estimate these empirical relationship (as lamented by (Lynch et al., 2004)). The omission of relevant controls implies, that these relationships may be estimated with bias, while multicollinearity between relevant confounding factors is likely to lead to incorrect inferences regarding statistical significance. All of which undermines the collective effort to decompose them in order to test various explanations. For example, although there is strong evidence for the AIH and some evidence for the IIH, "income inequality may not be capturing the hypothesized effects of social capital or psychosocial factors but rather the effects of state-level policies toward the poor that are correlated

[1] To an extent, Wilkinson and Pickett (2008) address the issue of functional misspecification of the induced inequality–income relationship.

[2] Note that Wagstaff and van Doorslaer (2000) and Lynch et al. (2004) identify a number of other hypotheses that are not as widely used as the AIH and IIH. The relative income and relative position hypotheses (e.g., Gravelle, 1998; Wilkinson, 1998) consider the deviation of an individuals income from the population mean income and an individual's position in the income distribution respectively. The deprivation hypothesis takes into account the extent of poverty and/or deprivation. These are not considered in this paper.

Please cite this article in press as: Schneider, M. P. A., & Yaşar, Y. Is inequality deadly and for whom? A Bayesian Model Averaging analysis. *The Social Science Journal* (2016), http://dx.doi.org/10.1016/j.soscij.2016.02.013